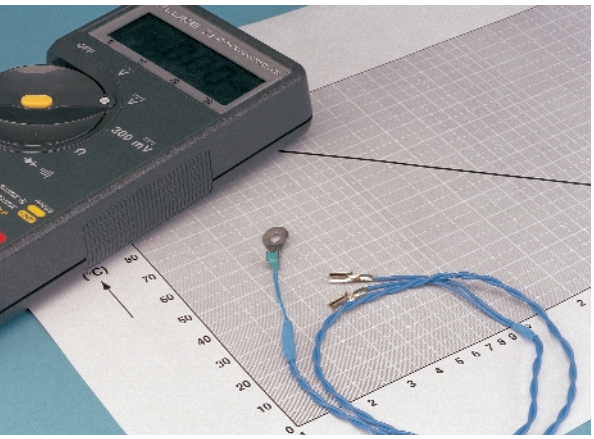
Measuring with an NTC

temperature measurement using a multimeter

By Bob Stuurman

It is often desirable to know how hot a part is. The usual method is to use a thermometer to measure the temperature, but this may not always be practicable.



However, with the help of a small NTC and a multimeter it is just as easy. During the development of a speed controller with a final stage consisting of MOSFETs, it was necessary to measure the temperature of these devices. A normal thermometer is unsuitable for this purpose, so a search was made for a sensor that could be secured to a MOSFET.

We found an NTC resistor, type 46720055, in the Conrad Electronics catalogue that appeared eminently suitable. The NTC has a flange with a hole with which it can be secured using a screw. This was exactly what we needed. But how could the measured resistance be easily converted to temperature?

Graph

First, two flexible leads, each 30 cm long, were soldered to the NTC terminals. Next, the NTC was securely fastened to a normal glass thermometer with a measuring range from 0 to 110 °C. This whole assembly was submerged in an electric kettle filled with water. After switching on, the measured resistance was recorded at every 5 °C temperature rise, until the water boiled. At this point the kettle was switched off. While the water cooled down, the resistance was recorded again at every 5 °C fall in temperature. It was noticed that the temperature indicated by the thermometer fell steadily but that the resistance fluctuated. Apparently, the NTC reacts faster to turbulence in the water than to the thermometer does.

It was hoped that a graph could be generated showing the linear relationship between temperature and resistance. But this was not so, the relationship appeared to be a logarithmic one. The graph shown here is the result. The function is a straight line when plotted using a logarithmic resistance scale. Not all measured data points lie exactly on a straight line. Also, differences between individual NTCs can cause variations. However, we may assume that the error will be smaller than 5%. The nominal value of the NTC is 10 kΩ at 25 °C. From the graph, at 10 kΩ, we read a value of approximately 23 °C. This is sufficiently accurate for our purposes.

Applications

Using the NTC, a DVM with an appropriate resistance range and the graph it becomes very simple to measure the temperature of a part. Because the NTC is small, it has very little thermal inertia. It quickly settles to the temperature of its environment and contributes little heat. It is easy to attach to a TO-220 MOSFET, an electric motor, or something similar. The thermal conductivity is very good because the mounting flange is made from brass. The NTC is small and light. As a consequence, vibrations — such as from an electric motor — have no influence on the measurement.

The horizontal axis of the graph is the measured resistance value. Going straight up from this value until you hit the curve allows you to read the corresponding temperature on the left.

Examples: 1000 Ω corresponds to a temperature of 90 °C, 2000 Ω corresponds to a temperature of 70 °C.

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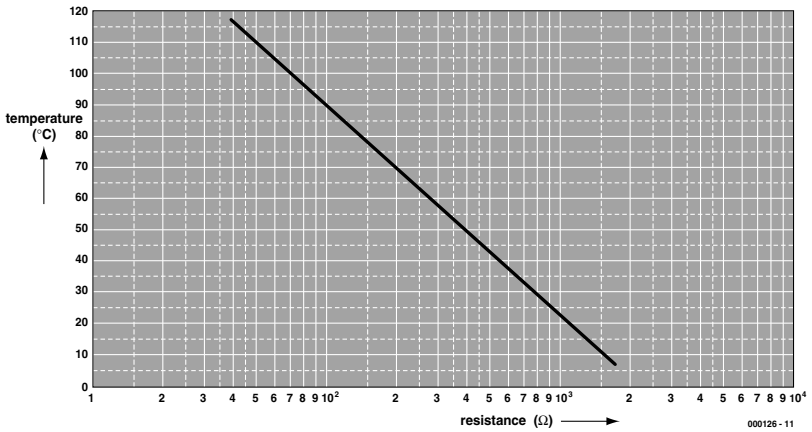

Figure 1. The resistance characteristic of an NTC forms a straight line if we use a logarithmic resistance scale.